

What is claimed is:

1 1. A process for forming a metal damascene structure,
2 comprising the following steps:

3 forming a dielectric layer on a substrate;
4 etching the dielectric layer to form a damascene
5 opening;

6 providing a plasma treatment to remove remaining
7 impurities on the dielectric layer; and
8 filling a metal in the damascene opening.

1 2. The process as claimed in claim 1, wherein the
2 plasma treatment uses a hydrogen-containing plasma, a
3 nitrogen-containing plasma, an oxygen-containing plasma,
4 or mixtures thereof.

1 3. The process as claimed in claim 2, wherein the
2 hydrogen-containing plasma is hydrogen (H₂) plasma or
3 ammonia (NH₃) plasma.

1 4. The process as claimed in claim 2, wherein the
2 nitrogen-containing plasma is nitrogen (N₂) plasma or
3 ammonia (NH₃) plasma.

1 5. The process as claimed in claim 2, wherein the
2 oxygen-containing plasma is N₂O plasma or oxygen (O₂)
3 plasma.

1 6. The process as claimed in claim 2, where the plasma
2 treatment step uses H₂ plasma, NH₃ plasma, H₂/NH₃ plasma,
3 or H₂/N₂ plasma.

1 7. The process as claimed in claim 1, wherein the
2 damascene opening is a via.

1 8. The process as claimed in claim 7, wherein the
2 damascene opening further comprises a trench above the
3 via.

1 9. The process as claimed in claim 8, wherein the
2 metal filling step includes filling copper or copper alloy
3 in the trench and the via.

1 10. The process as claimed in claim 1, before the
2 dielectric layer is formed, further comprising forming a
3 first metal layer on the substrate.

1 11. The process as claimed in claim 10, wherein the
2 first metal layer is copper or copper alloy.

1 12. The process as claimed in claim 11, wherein the
2 plasma treatment is performed on the surface of the first
3 metal layer.

1 13. The process as claimed in claim 12, wherein the
2 plasma treatment removes remaining impurities on the
3 first metal layer.

1 14. The process as claimed in claim 12, wherein the
2 plasma treatment repairs the bonding between the first
3 metal layer and the dielectric layer.

1 15. The process as claimed in claim 10, after the
2 first metal layer is formed and before the dielectric

3 layer is formed, further comprising forming a cap layer
4 on the first metal layer.

1 16. The process as claimed in claim 15, wherein the
2 cap layer is nitride or silicon carbide.

1 17. The process as claimed in claim 15, wherein the
2 plasma treatment repairs the bonding between the first
3 metal layer and the cap layer.

1 18. A process for forming a metal damascene
2 structure, comprising the following steps:

3 forming a cap layer on a first metal layer;

4 forming a dielectric layer on the cap layer;

5 etching the dielectric layer with
6 fluorine-containing plasma or
7 chlorine-containing plasma to form a damascene
8 opening;

9 plasma treating using a hydrogen-containing plasma;

10 and

1 19. The process as claimed in claim 18, wherein the
2 hydrogen-containing plasma is hydrogen (H_2) plasma or
3 ammonia (NH_3) plasma.

1 20. The process as claimed in claim 18, wherein the
2 plasma treatment step uses H₂ plasma, NH₃ plasma, H₂/NH₃
3 plasma, or H₂/N₂ plasma.

1 21. The process as claimed in claim 18, wherein the
2 damascene opening is a via.

1 22. The process as claimed in claim 21, wherein the
2 damascene opening further comprises a trench above the
3 via.

1 23. The process as claimed in claim 22, wherein the
2 metal filling step includes filling copper or copper alloy
3 in the trench and the via.

1 24. The process as claimed in claim 18, wherein the
2 first metal layer is copper or copper alloy.

1 25. The process as claimed in claim 18, wherein the
2 cap layer is nitride or silicon carbide.

1 26. A process for forming a metal damascene
2 structure, comprising the following steps:

3 forming a cap layer on a first metal layer, wherein
4 the cap layer is a nitride layer;
5 forming a dielectric layer on the cap layer;
6 etching the dielectric layer to form a damascene
7 opening;
8 plasma treating using a nitrogen-containing plasma;
9 and
10 filling a metal in the damascene opening.

1 27. The process as claimed in claim 26, wherein the
2 etching step uses fluorine-containing plasma or
3 chlorine-containing plasma.

1 28. The process as claimed in claim 26, wherein the
2 nitrogen-containing plasma is nitrogen (N₂) plasma.

1 29. The process as claimed in claim 26, wherein the
2 plasma treatment step uses NH₃ plasma, N₂ plasma, H₂/NH₃
3 plasma, or H₂/N₂ plasma.

1 30. The process as claimed in claim 26, wherein the
2 damascene opening is a via.

1 31. The process as claimed in claim 30, wherein the
2 damascene opening further comprises a trench above the
3 via.

1 32. The process as claimed in claim 31, wherein the
2 metal filling step includes filling copper or copper alloy
3 in the trench and the via.

1 33. The process as claimed in claim 26, wherein the
2 first metal layer is copper or copper alloy.

1 34. A process for forming a metal damascene
2 structure, comprising the following steps:

3 forming a cap layer on a first metal layer;
4 forming a dielectric layer on the cap layer;
5 forming a photoresist pattern on the dielectric
6 layer, wherein the photoresist pattern
7 contains carbon;
8 etching the dielectric layer using the photoresist
9 pattern as a mask to form a damascene opening;
10 plasma treating using an oxygen-containing plasma;
11 and
12 filling a metal in the damascene opening.

1 35. The process as claimed in claim 34, wherein the
2 etching step uses fluorine-containing plasma or
3 chlorine-containing plasma.

1 36. The process as claimed in claim 34, wherein the
2 oxygen-containing plasma is N₂O plasma or oxygen (O₂)
3 plasma.

1 37. The process as claimed in claim 34, wherein the
2 damascene opening is a via.

1 38. The process as claimed in claim 37, wherein the
2 damascene opening further comprises a trench above the
3 via.

1 39. The process as claimed in claim 38, wherein the
2 metal filling step includes filling copper or copper alloy
3 in the trench and the via.

1 40. The process as claimed in claim 34, wherein the
2 cap layer is nitride or silicon carbide.